編號： 123

國立成功大學 105 學年度碩士班招生考試試題

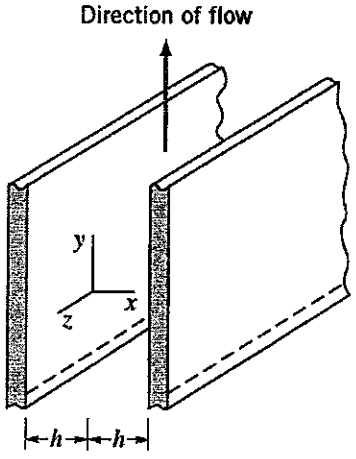
系　　所：工程科學系

考試科目：流體力學

考試日期：0228，節次：2

※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. [20%]請解釋下列名詞：馬赫數(Mach number)、雷諾數(Reynolds number)、流動分離(Flow separation)、升力係數(Lift coefficient)、阻力係數(Drag coefficient)、不可壓縮流(Incompressible flow)、黏滯性流體(Viscous fluid)、停滯點(Stagnation point)、帕斯卡定律(Pascal law)、雷諾應力(Reynolds stress)。
2. [15%] In the cylindrical coordinate ($\vec{e_r}$, $\vec{e_\theta}$, $\vec{e_z}$), a spatial vector $\vec{r}$ is expressed as follows: $\vec{r} = r\vec{e_r} + z\vec{e_z}$. Use the spatial vector $\vec{r}$ to derive the velocity formula, $\vec{V} = v_r\vec{e_r} + v_\theta\vec{e_\theta} + v_z\vec{e_z}$, and the acceleration formula, $\vec{a} = \frac{D\vec{V}}{Dt} = \left(\frac{Dv_r}{Dt} - \frac{v_\theta^2}{r}\right)\vec{e_r} + \left(\frac{Dv_\theta}{Dt} + \frac{v_r v_\theta}{r}\right)\vec{e_\theta} + \frac{Dv_z}{Dt}\vec{e_z}$, where ($v_r$, v_θ, v_z) are the velocity components in the ($\vec{e_r}$, $\vec{e_\theta}$, $\vec{e_z}$) directions, respectively. (13%) Write the material derivatives in both Cartesian and cylindrical coordinate systems. (2%)
3. [10%] State and explain the Reynolds transport theorem and its application to the conservation of mass.
4. [10%] Derive the Navier-Stokes equations from the Newton's second law of motion. (Note, define clearly all the variables.)
5. [10%] Derive the Bernoulli's equation from the Navier-Stokes equations. (Note, define clearly all the variables and state clearly the assumptions you need to make.)
6. [5%] Determine an expression for the vorticity of the flow field described by $V = -xy^3\hat{\imath} + y^4\hat{\jmath}$. Is the flow irrotational?
7. [10%] A viscous, incompressible fluid flows between the two infinite, vertical, parallel plates of the figure. Determine, by use of the Navier-Stokes equations, an expression for the pressure gradient in the direction of flow. Express your answer in terms of the mean velocity. Assume that the flow is laminar, steady, and uniform.



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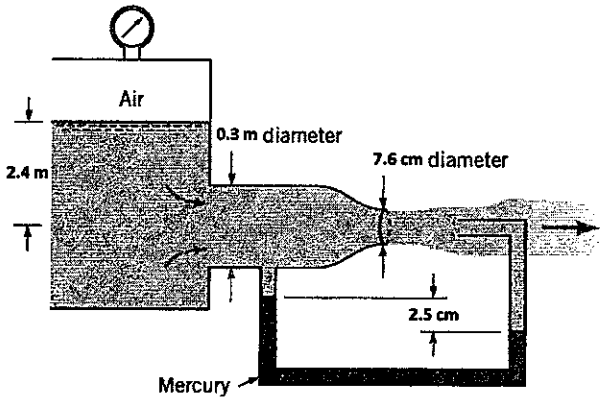
8. [10%] Water flows steadily from a large, closed tank as shown in the figure. The deflection in the mercury manometer is 2.5 cm and viscous effects are negligible. (a) Determine the volume flowrate. (b) Determine the air pressure in the space above the surface of the water in the tank. ($\gamma_{H_2O} = 9.81\ kN/m^3;\ SG_{Hg} = 13.56$)



9. [10%] A Pelton wheel vane directs a horizontal, circular cross-sectional jet of water symmetrically as indicated in the figure. The jet leaves the nozzle with a velocity of 30 m/s. Determine the x-direction component of anchoring force required to (a) hold the vane stationary, (b) confine the speed of the vane to a value of 3 m/s to the right. The fluid speed magnitude remains constant along the vane surface.